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replaced, mixed thoroughly, and the process repeated. It was previously decided to stop at the end of 600 trials. Throughout the work, the ratio of relatively prime pairs to total trials oscillated near the value .6, and at the conclusion, the number of relatively prime pairs was 364, a value surprisingly close to the correct theoretical value 364.8. Of course, an experiment involving, say, 10,000 trials would be more satisfying, but this result is perhaps not without interest.

493 (Algebra). Proposed by ALBERT BABBITT, University of Nebraska.

Determine the coefficients b, c, d of the equation $x^3 + bx^2 + cx + d = 0$ so that they shall be roots of the same equation. [From *Supplemento a Periodico di Matematica.*]

SOLUTION BY H. S. UHLER, Yale University.

Since the coefficient of x^3 is $+ 1$ and as b, c, d are to be roots, we have the following conditions:

$$-b = b + c + d \ (1), \qquad c = bc + cd + db \ (2), \qquad -d = bcd \ (3).$$

Equation (3) gives

$$d = 0 \ (4), \qquad \text{or} \qquad bc = -1 \ (5).$$

Combining (4) with (1) and (2) we get

$$2b + c = 0 \ (1'), \qquad bc - c = 0 \ (2').$$

Combining (5) with (1) and (2) we find $2b^2 + bd - 1 = 0$ (1″) and $b^2d - b$ - .

Equations (1′) and (2′) lead at once to the two pairs of values $b = 0$, $c = 0$, and $b = 1$. $c = -2$.

The factors of (2″) give $b = 1$ and $d = (b + 1)^{-1}$.

Substituting $b = 1$ in (5) and (1″) we find respectively $c = -1$ and $d = -1$. Replacing d by $(b + 1)^{-1}$ in (1″) gives

$$2b^3 + 2b^2 - 1 = 0. \tag{6}$$

The discriminant of (6) is positive so that this cubic has two complex roots and one positive real root. These roots may be expressed as

$$b = \tfrac{1}{6}[(46 + 6\sqrt{57})^{1/3} + (46 - 6\sqrt{57})^{1/3}] - \tfrac{1}{3}.$$

The approximate value of the real root, b_1, is

$$b_1 = +\,0.565,197,717,38.$$

Accordingly, the complex roots are approximately

$$b = \tfrac{1}{2}[-(b_1 + 1) + i\sqrt{(b_1 + 1)(3b_1 - 1)}],$$

or

$$b_2 = -\,0.782,598,858,69 + i0.521,713,717,94,$$

$$b_3 = -\,0.782,598,858,69 - i0.521,713,717,94.$$

The corresponding values of c and d may be found by the aid of (5) and $d = (b_1 + 1)^{-1}$, respectively. Finally, collecting all the results

b	c	d
0	0	0
1	-2	0
1	-1	-1
b_1	$-b_1^{-1}$	$(b_1 + 1)^{-1}$
b_2	$-b_2^{-1}$	$(b_2 + 1)^{-1}$
b_3	$-b_3^{-1}$	$(b_3 + 1)^{-1}$

Also solved by J. E. ROWE and the Proposer.

524 (Geometry). Proposed by NORMAN ANNING, Somewhere in France.

Many railways use as "easement curve" the cubic parabola. If points on such a curve are named by their distances measured along the curve from the point of inflection ("flat end")